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Water Chemicals Codex

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The Codex deals with the direct additives used to prepare drinking water. These chemicals are categorized according to use patterns, i.e. (a) coagulation and flocculation; (b) softening, precipitation and pH control; (c) disinfection and oxidation; and (d) miscellaneous treatment applications.

Impurities discussed on those already identified by the National Interim Drinking Water regulations as well as those deemed possible by virtue of manufacturing process or chemical similarity to the direct additive.

The basic form of the Codex is a series of individual monographs, each dealing with a specific compound. Each such monograph contains descriptive information such as physical properties, most common usage and dosage as well as recommended purity requirements.

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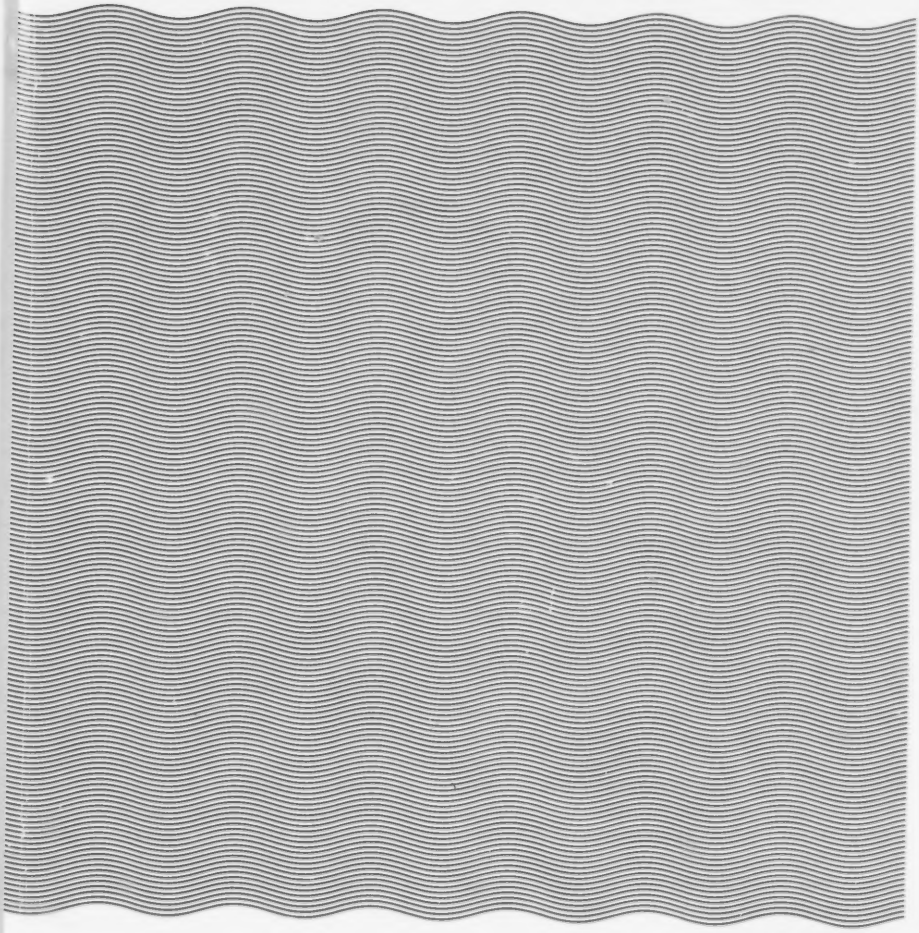
WATER CHEMICALS CODEX



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WATER CHEMICALS CODEX

Committee on Water Treatment Chemicals
Food and Nutrition Board
Assembly of Life Sciences
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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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Preface

In recognition of the fact that large segments of the U.S. population come in contact with chemical additives used in water disinfection, corrosion control, and fluoridation, a memorandum of understanding was signed in 1979 by which responsibility to monitor and control these additives, direct and indirect, was vested in the Environmental Protection Agency. Not long thereafter, in response to a request from that agency, the National Research Council undertook to recommend minimum acceptable purity specifications for such substances.

The Committee on Water Treatment Chemicals was formed and entrusted with the task of developing specifications, first for direct additives and, as feasible, later for indirect additives. The resulting "Codex" is meant to supplement existing compendia on water treatment chemicals and is confined to information on purity as related to health; it does not address product performance, packaging, storage, or handling.

In the course of its work, the committee was hampered by a lack of public data on the purity of water treatment chemicals and, therefore, has been forced to develop its recommendations on the basis of incomplete and largely unpublished data. As a result, the selection of impurities to be included in a Codex monograph was based upon the committee's knowledge of the processes used for manufacturing the water treatment chemical under consideration, or on similarities in the chemistry of the additive and its more likely impurities.

Analytical procedures were selected from compendia on analytical methodology or protocol, adopted from methods obtained from manufacturers, or derived from methods appearing in the scientific literature. Data on toxicologic aspects were obtained from the scientific litera-

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ture, from manufacturers of chemicals, and from the Code of Federal Regulations.

In carrying out its task, the committee was greatly aided by contributions from toxicologists and those experienced in analytical procedures. Explicit recognition and thanks are due to:

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WATER CHEMICALS CODEX

Findings and Recommendations

In the course of its study, the committee found little evidence to indicate that impurities present in direct drinking water additives cause gross contamination of water supplies. Therefore, the committee does not believe there is cause for alarm regarding the purity of direct drinking water additives currently used in the United States. Nonetheless, impurities of concern are known or suspected to be present in additives, and the committee recommends that the water treatment industry adopt voluntary standards of purity for these additives.

It is also recommended that more extensive data based on the purity of drinking water additives be developed and that this information be used to continuously revise and update this Codex.

Description of the Codex

It will be apparent that the body of the Codex is a series of individual monographs, each dealing with a specific compound. Each such monograph contains the following information:

1. Chemical name--alternative acceptable names
2. Chemical abstract service number
3. Chemical formula and formula weight
4. Physical properties
   a. Function
   b. Use range
5. Purity requirements
6. Bulk sampling procedures
7. Analytical procedures
   a. Sample preparation--special procedures are noted where appropriate. In cases where the chemical added is not soluble in water, the analytical procedures apply to a leachate of that material as obtained under the conditions described.
   b. Sample analysis--techniques are given either as citations of existing recognized procedures or as procedures developed specifically for the monograph.

Purity Requirements The committee recognizes that the assignment of purity requirements depends on the toxicity of the contaminant and the use patterns of the additive. The interpretation of toxicological data is at times controversial and depends on an evolving science. However, the toxicological data base for water impurities is improving steadily.

In arriving at its recommended contaminant limits, the committee met with the Environmental Protection Agency (EPA) to arrive at a list of priority chemicals--those that are used in largest quantities in the public water supply (Table 1). This list was then categorized according to use pattern, i.e., those used in (a) coagulation and flocculation; (b) softening, precipitation, and pH control; (c) disinfection and oxidation; and (d) miscellaneous treatment applications. In drafting the monographs in each category, a subgroup of the committee reviewed current data on known impurities in the chemicals, grade of manufactured products, use patterns, and other variables.

The committee also developed a list of impurities to be considered. The list was identical to the regulated inorganic impurities specified by the National Interim Drinking Water Regulations developed in response to the Safe Drinking Water Act of 1974 (Table 2).[1] This list was subsequently modified to include those substances for which there is evidence of occurrence as contaminants in water treatment chemicals. The toxicology subgroup of the committee supplied toxicological data on these sub-

TABLE 1 Water Treatment Chemicals Included in this Codex

Activated alumina	Sodium bicarbonate
Aluminum sulfate	Sodium calcium magnesium polyphosphate, glassy
Ammonia	Sodium carbonate
Ammonium hydroxide	Sodium chlorite
Bentonite clay	Sodium fluoride
Calcium hydroxide	Sodium hydroxide
Calcium hypochlorite	Sodium metabisulfite
Calcium oxide	Sodium polyphosphate, glassy
Carbon, activated, granular, and powder	Sodium silicate
Carbon dioxide	Sodium silicofluoride
Chlorine	Sodium tripolyphosphate
Ferric chloride	Sodium zinc polyphosphate, glassy
Ferric sulfate	Sodium zinc potassium polyphosphate, glassy
Ferrous sulfate	Sulfur dioxide
Fluosilicic acid	Sulfuric acid
Potasium permanganate	Tetrasodium pyrophosphate
Sodium aluminate	

TABLE 2 Calculated Values of RMIC (mg/kg) at Various Additive Use Levels

Substance	MCL mg/liter	CWTC mg/liter	Use Levels (expressed to one significant figure) 1 mg/liter	5 mg/liter	10 mg/liter	50 mg/liter	100 mg/liter	150 mg/liter	200 mg/liter
			RMIC	RMIC	RMIC	RMIC	RMIC	RMIC	RMIC
Arsenic	0.05		5,000	1,000	500	100	50	40	30
Barium	1		100,000	20,000	10,000	2,000	1,000	800	500
Cadmium	0.01		1,000	200	100	20	10	8	5
Carbon tetrachloride	--	[a]	----------100----------						
Chromium	0.05		5,000	1,000	500	100	50	40	30
Ether extractable matter	values are temperature dependent	[b]							
Fluoride									
Lead	0.05	[a]	5,000	1,000	500	100	50	40	30
Mercury	0.002		200	40	20	4	2	1	0.4
Nitrate	10		1,000,000	200,000	100,000	20,000	10,000	5,000	2,000
Pyridine		[b]							
Selenium	0.01		1,000	200	100	20	10	5	3
Silver	0.05		5,000	1,000	500	100	50	40	30
Trihalomethanes	0.1		10,000	2,000	1,000	200	100	80	50

[a] Calculated by NAS Committee on Water Treatment Chemicals.
[b] Applicable only to ammonium sulfate, purity defined by AWWA.

stances, including information on possible genotoxic effects.

Next, a suggested no-adverse-response level (SNARL)[2] was calculated for a potential contaminant. Irrespective of known genotoxicity, a SNARL may be calculated from existing data such as threshold limit value (TLV), which is available from a number of sources, and other parameters, including average body weight, intake, and exposure. In most cases, the calculated SNARL value differed from the TLV or the maximum contaminant level (MCL) found in the National Interim Drinking Water Regulations (NIDWR).[3]

In general, the committee felt it would be appropriate to utilize the MCL in calculating the allowable contaminant level contributed by an impurity in a water treatment chemical, unless there was no current MCL for that impurity or where there was new information concerning either the toxicity of the contaminant or the current status of the MCL.

In the case of lead, recent toxicological data are available that led the committee to recommend to the EPA that a lower MCL should be considered. However, the committee did not feel it consistent to adopt a smaller number in its calculations at this time.

A SNARL or MCL was thus converted to a recommended maximum impurity content (RMIC) in the additive by the following equation:

$$\text{RMIC} = \frac{\text{SNARL or MCL}}{\text{MD} \times \text{SF}}$$

$$= \frac{\text{SNARL or MCL (mg/liter)} \times 10^6 \text{ mg/kg}}{\text{MD (mg/liter)} \times \text{SF}}$$

Maximum dosage (MD) for the water treatment chemical was based upon maximum patterns known by the committee to be representative of water treatment practice.

The safety factor (SF) used in the calculation of the RMIC was 10, reflecting the view of the committee that no more than 10% of a given SNARL or MCL value should be contributed by a given impurity in a water treatment chemical. Some may argue for a higher safety factor, but 10 was chosen by the committee as reasonable in view of other uncertainties and approximations relating to the fate of impurities introduced during treatment.

A sample calculation of a RMIC is as follows:

Contaminant (Hg):

MCL 0.002 mg/liter

Water Treatment Additive:

Maximum Dose (MD) 500 mg/liter
Safety Factor 10

$$\text{RMIC} = \frac{0.002 \text{ mg Hg/liter} \times 10^6 \text{ mg/kg}}{500 \text{ mg Additive/liter} \times 10}$$

RMIC = 0.4 mg Hg/kg Additive

Table 2 contains RMIC values for impurities of concern at selected additive dose levels reported to one significant figure. RMIC values are also contained in the individual monographs and should be compared to impurity concentrations obtained by using the sample preparation described in the monograph. That is, the RMIC values represent maximum recommended impurity content and as such can be used as guidelines to the industry. The user is advised that, if actual dosages applied exceed those upon which the monograph is based, appropriate RMIC value should be extrapolated from Table 2.

The committee is aware that for some direct additives analyses of generally available grades show the presence of impurities at levels well below those that would be calculated as a RMIC. In such cases, RMIC values are not calculated, and the purity requirements are derived from those analyses.

If cases are found in which a contaminant may create additional health concern because of its radioactivity, RMIC values shall be calculated in accordance with radiation limits that appear in the Code of Federal Regulations.[1]

The RMIC levels are based upon information available to the committee. It is obviously impossible to recommend maximum impurities content levels for all possible unusual or unexpected impurities, the presence of which would depend upon method of manufacture and quality of raw material used. If other than recognized methods of manufacture or if unusual raw materials are used, the user should require appropriate certification of purity from the vendor or manufacturer to demonstrate the water treatment chemical is suitable for its application in the preparation of potable water. Material regenerated or reclaimed at the plant site or point of use must also meet Codex specifications.

Genotoxic Effects The genotoxic potential of water treatment chemicals impurities was evaluated on a case by case basis. Appropriate data bases were investigated and published risk assessments considered.

Epigenetic Effects Evidence for epigenetic effects was considered where appropriate. However, as in the case of carbon tetrachloride, sufficient data were not available to use epigenetic mechanisms as sole basis for determining minimum contaminant levels.

Analytical Methods Preferred sampling, sample preparation, and analytical methods for the determination of impurities are cited. It is recognized that a number of water treatment chemicals require special sample preparation and/or analysis due to matrix or other effects. For such chemicals the recommended special procedures are included in the Codex.

Methods that are cited or appear in the Codex should be considered the preferred analytical procedures; alternative methods may be used if they can be shown to be equivalent.

Revision It is expected that the Codex will be reviewed continuously and annual supplements issued. The supplements may contain additional chemicals and revisions of the monographs contained in the present Codex, as well as revision of analytical procedures.

LITERATURE CITED

1. Code of Federal Regulations, 40:141, 1981.
2. Safe Drinking Water Committee. 1980. Drinking Water and Health. National Academy of Sciences, Washington, D.C. 70 pp.
3. Environmental Protection Agency. 1976. National Drinking Water Regulations. EPA-570/9-76-003. Environmental Protection Agency, Washington, D.C.
4. American Water Works Association. 1981. Standard for Ammonium Sulfate. AWWA B302-81. American Water Works Association, Denver, Colorado.

Name: ALUMINUM SULFATE, ALUM

CAS No.: 10043-01-3 Formula Weight: 546.1

Chemical Formula: $Al_2(SO_4)_3 \cdot 14\ H_2O$

Description:

A white solid in the form of powder, crystals, or platelettes, or as a liquid. The most common degree of hydration is $Al_2(SO_4)_3 \cdot 14\ H_2O$. The commerical standard for water soluble alum is not less than 17.0% Al_2O_3 for solid and not less than 8.0% Al_2O_3 for liquid alum.

Use:

Used as a coagulant and precipitant for phosphate.

Purity Requirements:

The RMIC values are based on a maximum dosage of 150 mg aluminum sulfate*/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 150 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Aluminum Sulfate*
Arsenic	30
Cadmium	7
Chromium	30
Lead	30
Mercury	1
Selenium	7
Silver	30

*Calculated on the basis of $AL_2(SO_4)_3 \cdot 14\ H_2O$

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Bulk Sample Collection:

Sample in accordance with Standard for Aluminum Sulfate, AWWA B403-82, American Water Works Association, Denver, Colorado (1982).

Analytical Sample Preparation:

In preparing samples, use acid-washed glassware and make all dilutions with deionized distilled water. Weigh 1.5 g of aluminum sulfate (dry weight basis), dissolve, and make up to 1 liter in a volumetric flask. Transfer the solution to a 15-liter beaker; add 1 N NaOH dropwise with constant stirring to adjust to pH 6. Mix well, let stand for 1 hour, and filter through a GF/C filter (or equivalent) with vacuum. Quantitatively transfer filtrate into a beaker, adjust to pH 2 or less with concentrated HNO_3, and evaporate on a hot plate, without boiling, to reduce the volume to less than 1 liter. Cool, quantitatively transfer to a 1-liter volumetric flask, and make up to volume. Similarly, treat a reagent blank.

Sample Analyses:

The analyses are to be performed on the aluminum sulfate sample in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Cadmium	Section 304
Chromium	Section 304
Lead	Section 304
Mercury	Section 303F
Selenium	Section 304
Silver	Section 304

Name: AMMONIA, ANHYDROUS

CAS No.: 7664-41-7 Formula Weight: 17.0

Chemical Formula: NH_3

Description:

A colorless, liquified gas that is corrosive and has an irritating, pungent odor. Ammonia gas is capable of forming explosive mixtures with air. It is available at a commercial strength of 99.5% NH_3.

Use:

Used with chlorine during disinfection for control of trihalomethanes, tastes, and odors.

Purity Requirements:

A maximum dosage of 5 mg of NH_3/liter of water was considered, and at that dosage anhydrous ammonia is not known to contribute any contaminants that adversely affect the potability of drinking water.

Name: AMMONIUM HYDROXIDE, AQUA AMMONIA

CAS No.: 1336-21-6 Formula Weight: 35.0

Chemical Formula: NH_4OH

Description:

A clear colorless solution that is strongly alkaline and has an intense, pungent, suffocating odor. It is completely miscible in water and is available at a commercial strength of 29.4% NH_3.

Use:

Used with chlorine during disinfection for control of trihalomethanes, tastes, and odors.

Purity Requirements:

A maximum dosage of 10 mg of ammonium hydroxide/liter of water was considered and at that dosage ammonium hydroxide is not known to contribute any contaminants that adversely affect the potability of drinking water.

NAS/CWTC 004-82

Name: AMMONIUM SULFATE

CAS No.: 7783-20-2 Formula Weight: 132.0

Chemical Formula: $(NH_4)_2SO_4$

Description:

A reddish-white to brown crystalline solid that has a tendency to cake. It is available at a commercial strength of 99% ammonium sulfate.

Use:

Used with chlorine during disinfection for control of trihalomethanes, tastes, and odors.

Purity Requirements:

The RMIC values are based on a maximum dosage of 25 mg of ammonium sulfate/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 25 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Ammonium Sulfate
Arsenic	200
Pyridine	50
Selenium	40
Lead	200
Ether extractable matter	30

Bulk Sample Collection:

Sample in accordance with Standard for Ammonium Sulfate, AWWA B302-81, American Water Works Association, Denver, Colorado (1981).

Analytical Sample Preparation:

Weigh out 2.5 g of ammonium sulfate. In an acid-washed beaker, dissolve the sample with 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses--Inorganic:

The analyses are to be performed on the ammonium sulfate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Lead	Section 304
Selenium	Section 304

Sample Analyses--Organic:

The analyses are to be performed on the ammonium sulfate solution in accordance with:

Standard for Ammonium Sulfate, AWWA B302-81, American Water Works Association, Denver, Colorado (1981).

NAS/CWTC 005-82

Name: CALCIUM HYDROXIDE, SLAKED LIME

CAS No.: 1305-62-0 Formula Weight: 74.0

Chemical Formula: $Ca(OH)_2$

Description:

A white, dry fine powder, free from lumps, possessing an alkaline, slightly bitter taste. Solubility in water: 1 g/630 ml at 25°C, 1 g/1,300 ml at 100°C. Soluble in glycerin but insoluble in alcohol.

Use:

Used primarily as a softening agent and for pH adjustment.

Purity Requirements:

The RMIC values are based on a maximum dosage of 650 mg of calcium hydroxide/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 650 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Calcium Hydroxide
Arsenic	10
Cadmium	2
Chromium	10
Fluoride	*
Lead	10
Selenium	2
Silver	10

*A RMIC has not been established for fluoride. All producers of calcium hydroxide must analyze and state in the certified analysis the concentration of fluoride in the calcium hydroxide produced.

Bulk Sample Collection:

Sample in accordance with Standard for Lime, AWWA B202-77, American Water Works Association, Denver, Colorado (1977), except store final 2-lb sample in moistureproof glass.

Analytical Sample Preparation:

Take a 66.7-g portion of the sample and pulverize using a nonmetallic pulverizer or a glass mortar and pestle until sample passes a No. 100 U.S. standard sieve. Mix pulverized sample thoroughly and place in an airtight moistureproof glass container. Pippette 4 ml of deionized distilled water in a 150-ml beaker. Place on a 60°C hot plate. Place stirring rod in beaker and add 1.33 g of pulverized calcium hydroxide slowly while stirring. Mix paste thoroughly to include all pulverized sample. When a smooth paste is obtained, remove beaker from hot plate and slowly add 50 ml of 80°C deionized distilled water while stirring. Cool to room temperature. Filter through GF/C filter under vacuum into a 150-ml beaker.

Using a 25-ml burette, add 1+4 HNO_3 until the pH remains between 1.8 and 2.0 for 5 minutes. Transfer quantitatively into a 1,000-ml volumetric flask and dilute to volume with nitric acid dilution solution.

Analytical Sample Preparation--Fluoride:

Weigh 10 g of sample (to the nearest milligram) into a 400-ml beaker. Rehydrate the lime by slowly and carefully adding up to 250 ml of deionized water. Place 400 ml of deionized distilled water into a 1-liter side-arm distilling flask. Carefully add 200 ml of concentrated sulfuric acid. Swirl until contents are homogeneous (essential for safety during distillation). Add 25-35 glass boiling beads. Begin heating, slowly at first, until the temperature reaches 180°C. Discard the distillate. Cool the acid mixture. Carefully, quantitatively transfer the lime suspension to the distilling flask until all the slurry has been transferred along with 300 $\pm$ 5 ml of water (i.e., sample contained in 300 ml of water). If there is reason to suspect presence of chlorides in sample, add 5 mg of silver sulfate for every

milligram of chloride. Distill until flask temperature again reaches 180°C. Determine fluoride in the distillate.

Sample Analyses:

The analyses are to be performed on the calcium hydroxide solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Cadmium	Section 304
Fluoride	Section 413B
Selenium	Section 304
Silver	Section 304

Name: CALCIUM HYPOCHLORITE

CAS No.: 7778-54-3 Formula Weight: 143.1

Chemical Formula: $Ca(OCl)_2$

Description:

A white or yellowish-white powder with a strong chlorine odor; hygroscopic and corrosive. It is available at a commercial strength of 70% available Cl_2.

Use:

Used for disinfection, color removal, iron and manganese removal, and taste and odor control.

Purity Requirements:

The RMIC values are based on a maximum dosage of 20 mg of calcium hypochlorite/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 20 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Calcium Hypochlorite
Mercury	10

Bulk Sample Collection:

Sample in accordance with Standard for Calcium Hypochlorite, AWWA B300-80, American Water Works Association, Denver, Colorado (1980).

Analytical Sample Preparation:

Weigh out 2.5 g of calcium hypochlorite. In a 150-ml acid-washed beaker dissolve the sample in 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the calcium hypochlorite solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Mercury	Section 303F

All products used for disinfection that contain this compound must be registered as prescribed by the Federal Insecticide, Fungicide and Rodenticide Act.

Name: CALCIUM OXIDE (LIME, QUICKLIME)

CAS No.: 1305-78-8 Formula Weight: 56.0

Chemical Formula: CaO

Description:

Hard, white or grayish-white porous pebble or powder, odorless, and quick slaking. Solubility in water: 1 g/840 ml at 25°C, 1 g/1,740 ml at 100°C. Soluble in glycerin, but insoluble in alcohol.

Use:

Used primarily as a softening agent and for pH adjustments.

Purity Requirements:

The RMIC values are based on a maximum dosage of 500 mg of calcium oxide/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 500 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Calcium Oxide
Arsenic	10
Cadmium	2
Chromium	10
Fluoride	*
Lead	10
Selenium	2
Silver	10

*A RMIC has not been established for fluoride. All producers of calcium oxide must analyze and state the concentration of fluoride in the calcium oxide produced.

Bulk Sample Collection:

Sample in accordance with Standard for Lime, AWWA B202-77, American Water Works Association, Denver, Colorado (1977), except store final 2-lb sample in moistureproof glass.

Analytical Sample Preparation:

Crush about half of the 2-lb sample so that it passes a No. 6 U.S. standard sieve, preferably using a nonmetallic crusher or a glass mortar and pestle. Mix crushed sample thoroughly and place in an airtight moistureproof glass container. Take a 50-g portion of the crushed sample and pulverize using a nonmetallic pulverizer or a glass mortar and pestle until sample passes a No. 100 U.S. standard sieve. Mix pulverized sample thoroughly and place in an airtight moistureproof glass container.

Initial Slaking:

Pipette 4 ml of deionized distilled water in a 150-ml beaker. Place on a hot plate at a low heat and bring water to approximately 60°C. Place stirring rod in beaker and add 1 g pulverized calcium oxide slowly while stirring. If necessary, remove beaker from hot plate momentarily to control spattering. Mix slurry thoroughly to include all the pulverized lime. When a smooth paste is obtained, remove beaker from hot plate and slowly add 50 ml of 80°C deionized distilled water while stirring. Cool to room temperature. Filter through GF/C filter under vacuum into a 150-ml beaker. Using a 25-ml burette, add 1+4 HNO_3 until the pH remains between 1.8 and 2.0 for 5 minutes. Transfer quantitatively into a 1,000-ml volumetric flask and dilute to volume with nitric acid dilution solution.

Analytical Sample Preparation--Fluoride:

Weigh 10 g of sample (to the nearest milligram) into a 400-ml beaker. Rehydrate the lime by slowly and carefully adding up to 250 ml of deionized water. Place 400 ml of deionized distilled water into a 1-liter side-arm distilling flask. Carefully add 200 ml of concentrated sulfuric acid. Swirl until contents are homogeneous

(essential for safety during distillation). Add 25-35 glass boiling beads. Begin heating, slowly at first, until the temperature of the flask contents reaches 180°C. Discard the distillate. Cool the acid mixture. Quantitatively transfer the lime suspension (carefully) to the distilling flask until all the slurry has been transferred along with 300 ± 5 ml of water (i.e., sample contained in 300 ml of water). If there is reason to suspect presence of chlorides in sample, add 5 mg of silver sulfate for every milligram of chloride. Distill until flask temperature again reaches 180°C. Determine fluoride in the distillate.

Sample Analyses:

The analyses are to be performed on the calcium oxide solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	304
Cadmium	304
Chromium	304
Fluoride	413B
Lead	304
Selenium	304
Silver	304

Name: CARBON, ACTIVATED, GRANULAR

CAS No.: 7440-44-0 Formula Weight: 12.0

Chemical Formula: C

Description:

Black granular solid with enormous surface area; insoluble in water.

Use:

Adsorption and removal of color, odor, and other soluble substances from water.

Purity Requirements:

The RMIC values are based on a maximum dosage of 200 mg of activated carbon/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 200 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Activated Carbon
Arsenic	30
Chromium	30
Lead	30
Mercury	1
Silver	30

Bulk Sample Collection:

Sample in accordance with Standard for Granular Activated Carbon, AWWA B604-74, American Water Works Association, Denver, Colorado (1974).

Analytical Sample Preparation--Extraction Solution:

Add 47 ml of 0.1 N sodium hydroxide to 100 ml of 0.1 M potassium hydrogen phthalate and dilute with deionized water to 200 ml. Resultant solution will have a pH of 5 ± 0.05.

Weigh 5 g of GAC into a 400-ml beaker. Add 200 ml of extraction solution slowly to the carbon (it will effervesce). Cover and extract at room temperature on a magnetic stirrer for 1 hour ± 5 minutes. Filter through No. 41 filter paper. Determine trace metals in filtrate.

Sample Analyses:

The analyses are to be performed on the granular, activated carbon filtrate in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Chromium	Section 304
Lead	Section 304
Mercury	Section 303F
Silver	Section 304

Name: CARBON, ACTIVATED, POWDERED

CAS No.: 7440-44-0 Formula Weight: 12.0

Chemical Formula: C

Description:

Black powder with enormous surface area; insoluble in water.

Use:

Adsorption and removal of color, odor, and other soluble substances from water.

Purity Requirements:

The RMIC values are based on a maximum dosage of 200 mg of activated carbon/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 200 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Activated Carbon
Arsenic	30
Chromium	30
Lead	30
Mercury	1
Silver	30

Bulk Sample Collection:

Sample in accordance with Standard for Powdered Activated Carbon, AWWA B600-78, American Water Works Association, Denver, Colorado (1978).

Analytical Sample Preparation--Extraction Solution:

Add 47 ml of 0.1 N sodium hydroxide to 100 ml of 0.1 M potassium hydrogen phthalate and dilute with deionized water to 200 ml. Resultant solution will have a pH of 5 ± 0.05.

Weigh 5 g of PAC into a 400-ml beaker. Add 200 ml of extraction solution slowly to the carbon. Add 1 drop of nonionic detergent (wetting agent). Cover with watch-glass and begin extraction on magnetic stirrer, agitating slowly at first until all PAC is wetted and in suspension. Continue extraction for a total contact time of 1 hour ± 5 minutes. Filter through No. 41 filter paper. Use filtrate for analysis.

Sample Analyses:

The analyses are to be performed on the powdered, activated carbon filtrate in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Chromium	Section 304
Lead	Section 304
Mercury	Section 303F
Silver	Section 304

Name: CARBON DIOXIDE

CAS No.: 124-38-9 Formula Weight: 48.1

Chemical Formula: CO_2

Description:

A colorless, odorless, nonflammable gas, weighing 1.977 g/liter at 0°C and at a pressure of 760 mm of mercury. Solubility in water: one volume/volume of water and its solutions are acid.

Use:

Used primarily after lime softening as a stabilization agent to convert carbonates to bicarbonates.

Purity Requirements:

A maximum dosage of 100 mg of carbon dioxide/liter of water was considered, and at that dosage commercially available 99.5% purity carbon dioxide is not known to contribute any contaminants that adversely affect the potability of drinking water.

Name: CHLORINE

CAS No.: 7782-50-5

Formula Weight: 71.0

Chemical Formula: Cl_2

Description:

A greenish-yellow gas that liquifies under modest pressure to form an amber-colored liquid. As a gas it is corrosive and has a pungent, noxious odor. It has a solubility in water of 0.72 g/100 ml at 20°C and is available at a commercial strength of 99.8% chlorine.

Use:

Used for disinfection, color removal, iron and manganese removal, sulfide removal, and taste and odor control.

Purity Requirements:

The RMIC values are based on a maximum dosage of 30 mg of chlorine/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 30 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Chlorine
Carbon tetrachloride	100
Trihalomethanes	300
Mercury	7

Bulk Sample Collection:

Sample in accordance with Standard for Liquid Chlorine, AWWA B301-81, American Water Works Association, Denver, Colorado (1981).

Sample Analyses:

The analyses are to be performed on chlorine in accordance with:

Annual Book of ASTM Methods, American Society for Testing Materials, Philadelphia, Pennsylvania (1981).

Carbon tetrachloride	Section E806
Mercury	Section E506
Trihalomethanes	Section E806

All products used for disinfection that contain this compound must be registered as prescribed by the Federal Insecticide, Fungicide and Rodenticide Act.

NAS/CWTC 012-82

Name: FERRIC CHLORIDE

CAS No.: 7705-08-0 Formula Weight: 162.3

Chemical Formula: $FeCl_3$

Description:

Dark brown to yellow lumps or crystals. Solids are very hygroscopic. Solutions are corrosive. Usually available as a dark orange-brown liquid containing approximately 30% $FeCl_3$ by weight in water. May also be obtained as dark crystals with the formula $FeCl_3 \cdot 6H_2O$.

Use:

Used in coagulation.

Purity Requirements:

The RMIC values are based on a maximum dosage of 60 mg of ferric chloride/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 60 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Ferric Chloride
Arsenic	80
Cadmium	20
Chromium	80
Lead	80
Mercury	3
Selenium	20
Silver	80

Bulk Sample Collection:

Sample in accordance with Standard for Alum, AWWA B403-82, American Water Works Association, Denver, Colorado (1982).

Analytical Sample Preparation:

In preparing samples, use acid-washed glassware and make all dilutions with deionized distilled water. Weigh 0.6 g of ferric chloride (dry weight basis), dissolve, and make up to 1 liter in a volumetric flask. Transfer the solution to a 1.5-liter beaker, add 1 N NaOH dropwise with constant stirring to adjust to pH 6. Mix well, let stand for 1 hour, and filter through a GF/C filter (or equivalent) with vacuum. Quantitatively transfer filtrate into a beaker, adjust to pH 2 or less with concentrated HNO_3, and evaporate on a hot plate, without boiling, to reduce the volume to less than 1 liter. Cool, quantitatively transfer to a 1-liter volumetric flask, and make up to volume. Similarly treat a reagent blank.

Sample Analyses:

The analyses are to be performed on the ferric chloride solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Cadmium	Section 304
Chromium	Section 304
Lead	Section 304
Mercury	Section 303F
Selenium	Section 304
Silver	Section 304

Name: FERRIC SULFATE

CAS No.: 10028-22-5 Formula Weight: 399.8

Chemical Formula: $Fe_2(SO_4)_3 \cdot nH_2O$

Description:

Solid is red-gray to red-brown granules containing four to five waters of hydration. Usually used in solutions of 30-50% by weight ferric sulfate. Solutions are reddish-brown.

Use:

Used in coagulation.

Purity Requirements:

The RMIC values are based on a maximum dosage of 100 mg of ferric sulfate/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 100 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Ferric Sulfate
Arsenic	50
Cadmium	10
Chromium	50
Lead	50
Mercury	2
Selenium	10
Silver	50

Bulk Sample Collection:

Sample in accordance with Standard for Ferric Sulfate, AWWA B406-64, American Water Works Association, Denver, Colorado (1964).

Analytical Sample Preparation:

In preparing samples, use acid-washed glassware and make all dilutions with deionized distilled water. Weigh 1 g of ferric sulfate (dry weight basis), dissolve, and make up to 1 liter in a volumetric flask. Transfer the solution to a 1.5-liter beaker, add 1 N NaOH dropwise with constant stirring to adjust to pH 6. Mix well, let stand for 1 hour, and filter through a GF/C filter (or equivalent) with vacuum. Quantitatively transfer filtrate into a beaker, adjust to pH 2 or less with concentrated HNO_3, and evaporate on a hot plate, without boiling, to reduce the volume to less than 1 liter. Cool, quantitatively transfer to a 1-liter volumetric flask, and make up to volume. Similarly treat a reagent blank.

Sample Analyses:

The analyses are to be performed on the ferric sulfate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Cadmium	Section 304
Chromium	Section 304
Lead	Section 304
Mercury	Section 303F
Selenium	Section 304
Silver	Section 304

Name: FERROUS SULFATE

CAS No.: 7720-78-7 Formula Weight: 277.9

Chemical Formula: $FeSO_4 \cdot 7H_2O$

Description:

Pale, bluish-green crystals or granules. Ferrous salts tend to oxidize in moist air and form brownish-colored ferric salts. A 10% solution will have a pH of approximately 3.7. It is soluble in water and insoluble in alcohol.

Use:

Used in coagulation.

Purity Requirements:

The RMIC values are based on a maximum dosage of 80 mg of ferrous sulfate*/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 80 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Ferrous Sulfate
Arsenic	60
Cadmium	10
Chromium	60
Lead	60
Mercury	3
Selenium	10
Silver	60

*Calculated on basis of $FeSO_4 \cdot 7H_2O$.

Bulk Sample Collection:

Sample in accordance with Standard for Ferrous Sulfate, AWWA B402-68, American Water Works Association, Denver, Colorado (1968).

Analytical Sample Preparation:

In preparing samples, use acid-washed glassware and make all dilutions with deionized distilled water. Weigh 0.8 g of ferrous sulfate (dry weight basis), dissolve, and make up to 1 liter in a volumetric flask. Transfer the solution to a 1.5-liter beaker, add 1 N of NaOH dropwise with constant stirring to adjust to pH 6. Mix well, let stand for 1 hour, and filter through a GF/C filter (or equivalent) with vacuum. Quantitatively transfer filtrate into a beaker, adjust to pH 2 or less with concentrated HNO_3, and evaporate on a hot plate, without boiling, to reduce the volume to less than 1 liter. Cool, quantitatively transfer to a 1-liter volumetric flask, and make up to volume. Similarly treat a reagent blank.

Sample Analyses:

The analyses are to be performed on the ferrous sulfate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Cadmium	Section 304
Chromium	Section 304
Lead	Section 304
Mercury	Section 303F
Selenium	Section 304
Silver	Section 304

Name: FLUOSILICIC ACID, HYDROFLUOSILICIC ACID

CAS No.: 16961-83-4 Formula Weight: 88.0

Chemical Formula: H_2SiF_6

Description:

Available in 24-30% aqueous solution of fluosilicic acid; water white to straw yellow color with a pungent odor.

Use:

Used as source of fluoride.

Purity Requirements:

Analyses of available grades of fluosilicic acid show the presence of arsenic and lead but at levels far below that which would necessitate RMIC values based on a maximum dosage of 1.2 mg of fluoride ion/liter. If analyses are desired, the following protocol is recommended.

Bulk Sample Collection:

Sample in accordance with Standard for Fluosilicic Acid, AWWA B703-71, American Water Works Association, Denver, Colorado (1971).

Analytical Sample Preparation:

Weigh out 2.5 g of fluosilicic acid. In a 150-ml acid-washed beaker, dissolve the sample with 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HCl to a pH of less than 2. Add hydroxylamine hydrochloride until the solution turns clear. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitively

transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the fluosilicic acid sample in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Lead	Section 304

Name: POTASSIUM PERMANGANATE

CAS No.: 7722-64-7 Formula Weight: 158.0

Chemical Formula: $KMnO_4$

Description:

A dark purple crystal with a blue metallic sheen, having a sweetish, astringent taste and no odor. It has a solubility in water of 5.0 g/100 ml at 20°C and is available at a commercial strength of 97-99% potassium permanganate.

Use:

Used as an oxidant for removal of iron or manganese and for treatment of taste and odor.

Purity Requirements:

The RMIC values are based on a maximum dosage of 10 mg of potassium permanganate/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 10 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Potassium Permanganate
Cadmium	100
Chromium	500
Mercury	20

Bulk Sample Collection:

Sample in accordance with Standard for Potassium Permanganate, AWWA B603-77, American Water Works Association, Denver, Colorado (1977).

Analytical Sample Preparation:

Weigh out 2.5 g of potassium permanganate. In a 150-ml acid-washed beaker, dissolve the sample with 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HCl to a pH of less than 2. Add hydroxylamine hydrochloride until the solution turns clear. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the potassium permanganate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Cadmium	Section 304
Chromium	Section 304
Mercury	Section 303F

All products used for disinfection that contain this compound must be registered as prescribed by Federal Insecticide, Fungicide and Rodenticide Act.

NAS/CWTC 0017/82

Name: SODIUM ALUMINATE

CAS No.: 1302-42-7 Formula Weight: 82.0

Chemical Formula: $NaAlO_2$

Description:

A combination of sodium oxide and aluminum oxide with sufficient excess causticity to stabilize. Solid form usually contains 70-80% sodium aluminate; solutions, approximately 30% sodium aluminate.

Use:

Used as coagulant.

Purity Requirements:

The RMIC values are based on a maximum dosage of 40 mg of sodium aluminate/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 40 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Sodium Aluminate
Arsenic	100
Cadmium	30
Chromium	100
Lead	100
Mercury	5
Selenium	30
Silver	100

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Aluminate, AWWA B405-60, American Water Works Association, Denver, Colorado (1960).

Analytical Sample Preparation:

In preparing samples, use acid-washed glassware and make all dilutions with deionized distilled water. Weigh 0.4 g of sodium aluminate (dry weight basis), dissolve, and make up to 1 liter in a volumetric flask. Transfer the solution to a 1.5-liter beaker, add 1 N of NaOH dropwise with constant stirring to adjust to pH 6. Mix well, let stand for 1 hour, and filter through a GF/C filter (or equivalent) with vacuum. Quantitatively transfer filtrate into a beaker, adjust to pH of 2 or less with concentrated HNO_3, and evaporate on a hot plate, without boiling, to reduce the volume to less than 1 liter. Cool, quantitatively transfer to a 1-liter volumetric flask, and make up to volume. Similarly, treat a reagent blank.

Sample Analyses:

The analyses are to be performed on the sodium aluminate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Cadmium	Section 304
Chromium	Section 304
Lead	Section 304
Mercury	Section 303F
Selenium	Section 304
Silver	Section 304

Name: SODIUM CARBONATE, SODA ASH

CAS No.: 497-19-8 Formula Weight: 105.0

Chemical Formula: Na_2CO_3

Description:

Sodium carbonate, anhydrous is a white granular material. The alkali equivalent of 100% sodium carbonate is 58.48% sodium oxide.

Use:

Used for pH adjustment.

Purity Requirements:

The RMIC values are based on a maximum dosage of 100 mg of sodium carbonate/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 100 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Sodium Carbonate
Chromium	50
Lead	50

Bulk Sample Collection:

Sample in accordance with Standard for Soda Ash, AWWA B201-80, American Water Works Association, Denver, Colorado (1980).

Analytical Sample Preparation:

Weigh out 2.5 g of sodium carbonate. In a 150-ml acid-washed beaker, dissolve the sample with 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HCl to a pH of less than 2. Add hydroxylamine hydrochloride until the solution turns clear. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the sodium carbonate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Chromium	Section 304
Lead	Section 304

NAS/CWTC 019-82

Name: SODIUM CHLORITE

CAS No.: 7758-19-2 Formula Weight: 90.5

Chemical Formula: $NaClO_2$

Description:

Tan or white crystals or powder that are hygroscopic. This powerful oxidizing agent is explosive on contact with organic matter. It has a solubility in water of 39 g/100 ml at 17°C and is available at a commercial strength of 81.0-98.5% sodium chlorite.

Use:

Used for on-site production of chlorine dioxide.

Purity Requirements:

The RMIC values are based on a maximum dosage of 10 mg of sodium chlorite/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 10 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Sodium Chlorite
Mercury	20
Selenium	100

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Chlorite, AWWA B303-67, American Water Works Association, Denver, Colorado (1967).

Analytical Sample Preparation:

Pour 100 ml of sodium chlorite into a 150-ml acid-washed beaker. Under a hood, acidify the sample with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure. For the mercury analysis, use a separate 100-ml aliquot of sodium chlorite. Repeat the same preparation.

Sample Analyses:

The analyses are to be performed on the sodium chlorite solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Selenium	Section 304
Mercury	Section 303F

All products used for disinfection that contain this compound must be registered as prescribed by Federal Insecticide, Fungicide and Rodenticide Act.

NAS/CWTC 020-82

Name: SODIUM FLOURIDE

CAS No.: 7681-49-4 Formula Weight: 42.0

Chemical Formula: NaF

Description:

White or Nile blue fine powder or crystals and hygroscopic.

Use:

Used as source of fluoride.

Purity Requirements:

Analyses of available grades of sodium fluoride show the presence of arsenic and lead but at levels far below that which would necessitate RMIC values based on a maximum dosage of 1.2 mg fluoride ion/liter. If analyses are desired, the following protocol is recommended.

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Fluoride, AWWA B701-78, American Water Works Association, Denver, Colorado (1978).

Sample Analyses:

The analyses are to be performed on the sodium fluoride sample in accordance with:

Standard Method for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Lead	Section 304

NAS/CWTC 021/82

Name: SODIUM HYDROXIDE, CAUSTIC SODA

CAS No.: 1310-72-2 Formula Weight: 40.1

Chemical Formula: NaOH

Description:

Sodium hydroxide solutions are available in nominal concentrations of 50% sodium hydroxide and 73% sodium hydroxide. The solutions are clear or slightly turbid, colorless or slightly colored, and when exposed to the air they absorb carbon dioxide forming sodium carbonate. The alkali equivalent of 100% sodium hydroxide is 77.5% sodium oxide.

Use:

Used for pH adjustment.

Purity Requirements:

The RMIC are based on a maximum dosage of 100 mg of sodium hydroxide/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 100 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Sodium Hydroxide
Mercury	2

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Hydroxide, AWWA B501-75, American Water Works Association, Denver, Colorado (1975).

Analytical Sample Preparation:

Weigh out 2.5 g of sodium hydroxide. In a 150-ml acid-washed beaker, dissolve the sample with 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HCl to a pH of less than 2. Add hydroxylamine hydrochloride until the solution turns clear. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the sodium hydroxide solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Mercury	Section 303F

NAS/CWTC 023-82

Name: SODIUM METABISULFITE, SODIUM PYROSULFATE

CAS No.: 7631-90-5 Formula Weight: 174.1

Chemical Formula: $Na_2S_2O_5$

Description:

White to slight yellow crystals with a sulfurous odor. When in solution, sodium metabisulfite is formed. It has a solubility in water of 54 g/100 ml at 20°C and is available at a commercial strength of 97.5-99.0% sodium metabisulfite.

Use:

Used to remove chlorine and other oxidants.

Purity Requirements:

The RMIC values are based on a maximum dosage of 15 mg of sodium metabisulfite/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 15 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Sodium Metabisulfite
Arsenic	300
Selenium	70

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Metabisulfite, AWWA B601-77, American Water Works Association, Denver, Colorado (1977).

Analytical Sample Preparation:

Weigh out 2.5 g of sodium metabisulfite. In a 150-ml acid-washed beaker, dissolve the sample in 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the sodium metabisulfite sample in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Selenium	Section 304

NAS/CWTC 024-82

Name: SODIUM POLYPHOSPHATE, GLASSY

CAS No.: 10124-56-8

Chemical Formula: $(NaPO_3)_n \cdot Na_2O$ Typically, n = 14

Na_2O/P_2O_5 = 1.1 to 1.3

P_2O_5 = 63-68%

Description:

Colorless, odorless, glassy solid, plates, granules, or powder. Slight salty taste. Hygroscopic and extremely soluble in water.

Use:

Used as metal corrosion inhibitor and sequestrant to avoid iron, copper and manganese discoloration. Threshold scale inhibitor and water softener.

Purity Requirements:

Analyses of available grades of glassy sodium polyphosphate show the presence of cadmium and lead but at levels far below that which would necessitate RMIC values based on a maximum dosage of 10.7 mg/liter. If analyses are desired, the following protocol is recommended.

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Tripolyphosphate, AWWA B503-78, American Water Works Association, Denver, Colorado (1978).

Analytical Sample Preparation:

Weigh out 2.5 g of sodium polyphosphate. In a 150-ml acid-washed beaker dissolve the sample in 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the sodium polyphosphate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Cadmium	Section 304
Lead	Section 304

NAS/CWTC 025-82

Name: SODIUM SILICOFLUORIDE, SODIUM FLUOSILICATE

CAS No.: 16893-85-9 Formula Weight: 132

Chemical Formula: Na_2SiF_6

Description:

White, yellowish-white, or Nile blue crystalline powder, odorless, acidic taste, and hygroscopic.

Use:

Used as source of fluoride.

Purity Requirements:

Analyses of available grades of sodium silicofluoride show the presence of arsenic and lead but at levels far below that which would necessitate RMIC values based on a maximum dosage of 1.2 mg of fluoride ion/liter. If analyses are desired, the following protocol is recommended.

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Silicofluoride, AWWA B702-74, American Water Works Association, Denver, Colorado (1974).

Analytical Sample Preparation:

Weigh out 2.5 g of sodium silicofluoride. In a 150-ml acid-washed beaker, dissolve the sample with 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HCl to a pH of less than 2. Add hydroxylamine hydrochloride until the solution turns clear. Gently heat the solution to reduce the volume

below 100 ml, making certain that it does not boil. Quantitively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the sodium silicofluoride sample in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Lead	Section 304

NAS/CWTC 026-82

Name: SULFUR DIOXIDE

CAS No.: 7446-09-5 Formula Weight: 64.0

Chemical Formula: SO_2

Description:

A colorless gas that liquifies under pressure to form a colorless liquid. As a gas it is corrosive and has a suffocating, pungent odor. When in solution, H_2SO_3 is formed. It has a solubility in water of 11.3 g/100 ml at 20°C and is available at a commercial strength of 100% sulfur dioxide.

Use:

Used to remove chlorine and other oxidants from water.

Purity Requirements:

The RMIC values are based on a maximum dosage of 10 mg of sulfur dioxide/liter of water and are to be compared to impurity concentrations obtained by using sample procedures described in this monograph. If the actual dosage is other than 10 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg Impurity/kg Sulfur Dioxide
Arsenic	500
Selenium	100

Bulk Sample Collection:

A 300-ml sample of sulfur dioxide injection water should be collected at the point of application. A 300-ml sample of the injection water prior to sulfur dioxide

addition should also be collected and used for a sample blank. The latter sample should be preserved with 1 ml of concentrated HNO_3.

Analytical Sample Preparation:

Pour 100 ml of sulfur dioxide injection water sample into a 150-ml acid-washed beaker. Determine if the sample has a pH of less than 2. If it does not, acidify the sample with concentrated HNO_3 to a pH of less than 2. Transfer to a 100-ml acid-washed volumetric flask. Repeat this preparation procedure with 100 ml of the sample blank. For the mercury analysis, use a separate 100-ml aliquot of sulfur dioxide injection water and sample blank. Repeat the same preparation.

Sample Analyses:

The analyses are to be performed on the sulfur dioxide sample in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Arsenic	Section 304
Selenium	Section 304

Name: ACTIVATED ALUMINA

CAS No.: 1344-28-1

Chemical Formula: $Al_2O_3 \cdot xH_2O$ Where x = approx. 0.4

Description:

White, odorless, insoluble granules.

Use:

Used to remove arsenic, fluoride, and selenium.

Purity Requirements:

Analyses of available grades of activated alumina show the presence of chromium but at levels far below that which would necessitate RMIC values based on a maximum use of 2 g/liter of water. If analyses are desired, the following protocol is recommended.

Bulk Sample Collection:

Sample in accordance with Standard for Granular Activated Carbon, AWWA B604-74, American Water Works Association, Denver, Colorado (1974).

Analytical Sample Preparation:

Extraction Solution--Add 47 ml of 0.1 N sodium hydroxide to 100 ml of 0.1 M potassium hydrogen phthlate and dilute with deionized water to 200 ml. The resultant solution will have a pH of 5 $\pm$ 0.05.

Sample Preparation--Grind sample to fit through a 40-mesh screen. Weigh 5 g of sample into a 400-ml beaker and add 200 ml of extraction solution. Add 1 drop of nonionic

detergent (wetting agent). Cover with watch glass and agitate with a magnetic stirrer for 1 hour ± 5 minutes. Filter through No. 40 Whatman filter paper. Use filtrate for analyses.

Sample Analyses:

Analyze the filtrate in accordance with Standards Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

NAS/CWTC 028/82

Name: BENTONITE-TYPE CLAY

CAS No.: 1302-78-9 Formula Weight: Unknown

Chemical Formula: Undefinable

Description:

White to pale tan powder.

Use:

Used as clarification aid.

Purity Requirements:

A maximum dosage of 15 mg clay/liter of water was considered, and at that dosage bentonite-type clays are not known to contribute any contaminants that adversely affect the potability of drinking water.

NAS/CWTC 031/82

Name: SODIUM BICARBONATE

CAS No.: 144-55-8 Formula Weight: 84.0

Chemical Formula: $NaHCO_3$

Description:

White, free-flowing, odorless crystalline material. Solubility is 99.6 g/liter of water. The pH of a 1% solution is 8.4.

Use:

Used to reduce hardness.

Purity Requirements:

A maximum dosage of 150 mg of sodium bicarbonate/liter of water was considered, and at that dosage sodium bicarbonate is not known to contribute any contaminants that adversely affect the potability of drinking water.

NAS/CWTC 032-82

Name: SODIUM CALCIUM MAGNESIUM POLYPHOSPHATE, GLASSY

CAS No.: 65997-17-3 Formula Weight: Unknown

Chemical Formula: $(MPO_3)_n \cdot M_2O$ Where M = Na, 1/2 Ca, 1/2 Mg

n = 5

P_2O_5 = 66-70%

Description:

White to colorless plates, granules or powder.

Use:

Corrosion inhibitor, stabilizer for dissolved copper, iron, and magnesium and as a threshold scale inhibitor.

Purity Requirements:

Analyses of available grades of sodium calcium magnesium polyphosphate (glassy) show the presence of cadmium and lead, but at levels far below that which would necessitate RMIC values based on a maximum dosage of 15 mg/liter. If analyses are desired, the following protocol is recommended.

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Tripolyphosphate, AWWA B503-78, American Water Works Association, Denver, Colorado (1978).

Analytical Sample Preparation:

Weigh out 2.5 g of sodium calcium magnesium polyphosphate. In a 150-ml acid-washed beaker, dissolve the sample in 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the sodium calcium magnesium polyphosphate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Cadmium	Section 304
Lead	Section 304

NAS/CWTC 033/82

Name: SODIUM SILICATE, ACTIVATED SILICA

CAS No.: 1344-09-8 Formula Weight: 242 for n = 1

Chemical Formula: $Na_2O(SiO_2)_n$ Typically n = 3

Description:

Colorless, turbid aqueous solution.

Use:

Used as metal corrosion inhibitor, clarification aid, and stabilizer for iron and manganese.

Purity Requirements:

A maximum dosage of 16 mg of sodium silicate/liter of water was considered, and at that dosage sodium silicate is not known to contribute any contaminants that adversely affect the potability of drinking water.

NAS/CWTC 035/82

Name: SODIUM TRIPOLYPHOSPHATE

CAS No.: 7758-29-4

Chemical Formula: $Na_5P_3O_{10}$ $Na_5P_3O_{10} \cdot 6H_2O$

Formula Weight: 368 476

Description:

White, odorless granules or powder.

Use:

Used as corrosion inhibitor, sequestrant, and water softener.

Purity Requirements:

The analyses are to be performed on the sodium tripolyphosphate show the presence of cadmium and lead but at levels far below that which would necessitate RMIC values based on a maximum dosage of 12.9 mg/liter. If analyses are desired, the following protocol is recomended.

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Tripolyphosphate, AWWA B503-78, American Water Works Association, Denver, Colorado (1978).

Analytical Sample Preparation:

Weigh out 2.5 g of sodium tripolyphosphate. In a 150-ml acid-washed beaker, dissolve the sample in 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than

2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the sodium tripolyphosphate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Cadmium	Section 304
Lead	Section 304

NAS/CWTC 036-82

Name: SODIUM ZINC POLYPHOSPHATE, GLASSY

CAS No.: 65997-17-3 Formula Weight: Unknown

Chemical Formula: $(MPO_3)_n \cdot M_2O$ Where M = Na and/or 1/2 Zn

n = 5

P_2O_5 = 55-61%

Description:

White to colorless glassy plates, granules or powder.

Use:

Corrosion inhibitor.

Purity Requirements:

Analyses of available grades of glassy sodium zinc polyphosphate show the presence of cadmium and lead, but at levels far below that which would necessitate RMIC values based on a maximum dosage of 12.3 to 13.6 mg/liter, depending on the P_2O_5 content of the specific product used. If analyses are desired, the following protocol is recommended.

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Tripolyphosphate, AWWA B503-78, American Water Works Association, Denver, Colorado (1978).

Analytical Sample Preparation:

Weigh out 2.5 g of sodium zinc polyphosphate. In a 150-ml acid-washed beaker, dissolve the sample in 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the sodium zinc polyphosphate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Cadmium	Section 304
Lead	Section 304

Name: SODIUM ZINC POTASSIUM POLYPHOSPHATE, GLASSY

CAS No.: 65997-17-3

Chemical Formula: $(MPO_3)_n \cdot M_2O$ Where M = Na
= K
= 1/2 Zn
n = 5

P_2O_5 = 53-55%

Description:

White to colorless glassy plates, granules or powder.

Use:

Used as corrosion inhibitor.

Purity Requirements:

Analyses of available grades of glassy sodium zinc potassium polyphosphate show the presence of cadmium and lead, but at levels far below that which would necessitate RMIC values based on a maximum dosage of 13.7 to 14.1 mg/liter, depending on the P_2O_5 content of the specific product used. If analyses are desired, the following protocol is recomended.

Bulk Sample Collection:

Sample in accordance with Standard for Sodium Tripolyphosphate, AWWA B503-78, American Water Works Association, Denver, Colorado (1978).

Analytical Sample Preparation:

Weigh out 2.5 g of sodium zinc potassium polyphosphate. In a 150-ml acid-washed beaker, dissolve the sample in

100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quantitatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the sodium zinc potassium polyphosphate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Cadmium	Section 304
Lead	Section 304

NAS/CWTC 038/82

Name: SULFURIC ACID (OIL OF VITRIOL)

CAS No: 7664-93-9 Formula Weight: 98.0

Chemical Formula: H_2SO_4

Description:

Hygroscopic, syrupy corrosive liquid.

Use:

Used in pH adjustment following lime softening. Preparation of activated silica from sodium silicate. Regeneration of resins.

Purity Requirements:

Analyses of available grades of sulfuric acid show the presence of selenium, arsenic, and lead. For arsenic and lead the levels are far below that which would necessitate RMIC values based on a maximum dosage of 50 mg/liter. If the actual dosage is other than 50 mg/liter, the user is cautioned to consult Table 2 for appropriate RMIC values.

Impurity	RMIC mg/Impurity/kg Sulfuric Acid
Selenium	20

Analytical Sample Preparation:

To an acid-washed 500-ml volumetric flask, add approximately 250 ml of deionized water. Slowly, and with agitation, add 5 ml of sample to the water in the flask. Caution: Eye protection must be worn during this procedure! Excessive heat buildup may result if sample is added to water too rapidly.

Sample Analyses:

Analyze the sulfuric acid solution in accordance with Standards Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1980).

Chromium	Section 304
Lead	Section 304
Selenium	Section 304

NAS/CWTC 039/82

Name: TETRASODIUM PYROPHOSPHATE

CAS No: 7722-88-5

Chemical Formula: $Na_4P_2O_7$ $Na_4P_2O_7 \cdot 10H_2O$

Formula Weight: 266 446

Description:

White, odorless crystals or granules.

Use:

Used as corrosion inhibitor.

Purity Requirements:

Analyses of available grades of tetrasodium pyrophosphate show the presence of cadmium and lead but at levels far below that which would necessitate RMIC values based on a maximum dosage of 14 mg/liter.

Bulk Sample Collection:

Sample in accordance with the Standard for Sodium Tripolyphosphate, AWWA B503-78, American Water Works Association, Denver, Colorado (1978).

Analytical Sample Preparation:

Weigh out 2.5 g of tetrasodium pyrophosphate. In a 150-ml acid-washed beaker, dissolve the sample in 100 ml of deionized distilled water. Under a hood, acidify the solution with concentrated HNO_3 to a pH of less than 2. Gently heat the solution to reduce the volume below 100 ml, making certain that it does not boil. Quanti-

tatively transfer to a 100-ml acid-washed volumetric flask and make to volume with deionized distilled water. Process a reagent blank by the same procedure.

Sample Analyses:

The analyses are to be performed on the tetrasodium pyrophosphate solution in accordance with:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, American Public Health Association, Washington, D.C. (1981).

Cadmium	Section 304
Lead	Section 304